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IMPACT OF KEEL-LENGTH TYPE AND PLUMAGE INTERACTION ON JUVENILE GROWTH PERFORMANCE AND CARCASS COMPONENTS OF JAPANESE QUAILS

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ABSTRACT

The foundation stock was established using fertilized eggs of three different colored strains brought from College of Agricultural Cairo University. The experimental flocks were hatched from 1500 eggs (500 of each Plumage group). The produced birds raised at the experimental farm, Department of Animal and Poultry Production, Faculty of Environmental Agricultural Sciences, Suez Canal University, El-Arish, North Sinai, Egypt, during the period from October 2011 to November 2012. Quail colored groups were: 1. The Wild Black type, Bl; 2. The Light Brown type, Br and 3. The White type, Wt (sometimes labeled with few colored short feather in their dorsal back and/or heads). Individual divergent selection for 4-wk-keel-length was carried out. At 4 wk of age birds within each Color Plumage Type were descendingly sorted according to their keel length. The upmost 1/3 ranked birds, in each Color Plumage Type were considered as the high keel length selected line (H-line), while the lowest 1/3 ranked ones were considered the low keel length selected line (L-line). The rest of each respective group were considered as controls, C. The interaction between Plumage-Color and keel-length Types gave rise to 9 experimental groups as follows G1 = (Bl_H); G2 = (Bl_C); G3 = (Bl_L); G4 = (Br_H); G5 = (Br_C); G6 = (Br_L); G7 = (Wt_H); G8 = (Wt_C); G9 = (Wt_L).The experimental diet used was a single growing corn-soybean growing diet in a mash form with approximately 23% crude protein and 2850 kcal ME/kg. Feed and water offered ad libitum and all birds were treated the same. Results indicated that the interaction between keel selection type and birds color type was from significant to highly significant on all growth Traits. As for body weight (BW), the heaviest BW combination at all studied ages was the White -long -keeled birds (Wt-H line). The case was fluctuating as for the relative growth rate (RGR), the highest group was from the long-keeled birds but for the Whites, Wt_H at 2 wk and the Blacks, Bl_H at 4-6 wk. However for the superior 2-4 wk combination was the Black-short-keeled birds, (Bl_L) meanwhile for 6-8 wk it was for the Brown-short-keeled birds, (Br_L).As regard to weight Gain (WG), the highest WG combination was for the long-keeled, (H line) birds. The highest WG in 0-2 wk and 0-8 wk represented for the White birds. However, the highest WG combination at 2-4 wk and 6-8 wk was achieved by the Browns. On the other hand the highest WG combination at 4-6 wk, was by the Blacks.

For keel- by color- types interaction gave no substantial or noteworthy trend on various percentages of carcass components, there was no significant effect of this interaction on all carcass components except that for the right testis weight (where P< 0.0004).

Key words: Japanese quail, Keel length, plumage color, Growth Performance, divergent selection, Carcass Components.

INTRODUCTION

Japanese quail is considered as an ideal laboratory bird for its rapid growth, early sexual maturity, short generation interval and relatively high egg production. **Wilson et al. (1961)** suggested using Japanese quail as a pilot experimental animal for chickens and turkeys studies.

The use of selection as a tool to improve meat and egg production in poultry has been documented in the early forties and fifties of the last century by **Hazel and Lush (1942)**, and **Lerner (1958)**. Body weight, gain in body weight, and growth rate are attractive selection parameters because they are relatively easy to attain and requires only body weight measurements. Selection has been adopted as a major strategy for the improvement of growth rate in a variety of animals, about 85 to 90% of the improvement in growth of broilers has come about through selection for body weight **(Reddy, 1996).**

In this respect, selection response is generally represented as an important genetic parameter to improve the economic traits and produce desirable traits in the domestic animals. Because the relationships among these economic traits are divergent: direct or indirect as well as genetic or non-genetic, the balance between them needs to be taken into account in a selection experiment **(Peebles and Marks, 1991)**.

Short-term selection experiments are excellent for checking the theoretical predictions made from estimates of genetic parameters in the base population, for testing for nonlinearity of direct and correlated responses to different selection intensities and selection directions, for comparing rates of response in alternate breeding schemes, and for studying of genotype by environment interactions **(Reddy, 1996).** However, short-term selection cannot provide information on the long-term effects of selection, which is more relevant to commercial breeding operations.

However, scarce work, if any, has been done on the effect of divergent selection for keel length on Japanese quail growth traits. This type of selection can make an alternate especially when direct selection for growth lacks response. Furthermore, since the keel is the frame on which the pectoral muscles of the breast are carried upon, the largest muscle and edible part on quails, it is expected that enlarging to some extent this important carcass component would cause a push to quails growth. Therefore, this work has been carried out to investigate the indirect response of divergent selection for keel length on quail growth (body weight, gain in weight and growth rate) and carcass components traits.

MATERIALS AND METHODS

Experimental Birds were raised at the experimental farm, Department of Animal and Poultry Production, Faculty of Environmental Agricultural Sciences, Suez Canal University, El-Arish, North Sinai, Egypt. A total number of 342 Japanese quail (171 males and 171 females) were divided randomly within color type. Therefore, the base populations were consisted of three

a. the wild type (black) b. the brown type c. the white type

plumage color types: The Wild Black type, Bl; the Light Brown type, Br and the White type, Wt (sometimes labeled with few colored short feather in their dorsal back and/or heads), **Figure 1.**

Eggs were collected daily and marked according to their respective pen number (Applying the biosecurity procedure). Healthy hatched chicks were leg banded. All through the experimental period; feeds were allowed *ad libitum* in a mash form diet with 23% and 20% crude protein for growing and layer diet, respectively and 2850 kcal ME/kg).

Selection and mating methods:

Individual divergent selection for keel length at 4 wk of age was applied. The upmost 1/3 ranked birds, in each Color Plumage Type were considered as the high keel length selected line (H-line), while the lowest 1/3 ranked ones were considered the low keel length selected line (L-line). The rest of each respective group were considered as controls, C.

The interaction between Plumage-Color and keel-length Types gave rise to 9 experimental groups as follows:

G1 = (Bl_H); G2 = (Bl_C); G3 = (Bl_L); G4 = (Br_H); G5 = (Br_C); G6 = (Br_L); G7 = (Wt_H); G8 =(Wt_C); G9 = (Wt_L). At 5 wk of age, each female was assigned at random to a non-sib male from the same type.

Studied traits and statistical analysis:

Individual body weight (BW) were recorded at hatch, 2, 4, 6 and 8 wk of age and were denoted BW0, BW2, BW4, BW6, and BW8; respectively. Weight (WG) and relative growth rate (RGR) were calculated for all periods from hatch till 8 wk of age. However, keel length was measured at 4, 6 and 8 wk of age. Keel length at 4 wk of age was used as selection criteria. Carcass traits measured were, live weight, slaughter weight (was obtained after five minutes bleeding), shed blood weight (deducting the slaughter from the life weight). Head weighed separately. Carcass weight was obtained by weighing the empty carcass after the removal of head, neck, shank, and viscera (expect giblets clean gizzard, heart and liver).

The following internal organs were weighed: heart, glandular and muscular stomach, gut, liver, spleen and sex organs (ovary & oviduct and testes).

Data were analyzed using the general linear model procedure of SAS 7 package **(SAS, 2004).** Data were classified into several major sets:

Growth traits, which include body weight, gain in weight, growth rate and keel-length slaughter traits, which include the percentages of feather, blood, eviscerated weights, heart, liver and gizzard, head, spleen, glandular and muscular stomach, gut and sex organs (ovary & oviduct and testes), as well as keel length.

Data of (growth and slaughter traits were analyzed within each generation using Least Squares ANOVA applying the following model:

$$\mathbf{Y_{ijk} = \mu + T_i + S_j + B_k + H_l + TS_{ij} + TB_{ik} + SB_{jk} + TSB_{ijk} + e_{ijk}}$$

Where:

$\mathbf{Y_{ijk}}$ = Individual observation for the trait.

$\mathbf{\mu}$ = the overall mean for the trait under consideration;

$\mathbf{T_i}$ = the fixed effect of the i^{th} selection type (control, high and low keel length)

$\mathbf{S_j}$ = the fixed effect of the j^{th} sex (Male, female).

$\mathbf{B_k}$ = the fixed effect of the k^{th} group identified by feather color (the Blacks or wild type; The Browns; the Whites).

$\mathbf{H_l}$ = the fixed effect of the l^{th} Hatch effect (1^{st}, 2^{nd}, 3^{rd}).

TS_{ij} = the fixed effect of the two-factor interaction between the i^{th} selection type and the j^{th} sex.

TB_{ik} = the fixed effect of the two-factor interaction between the i^{th} selection type and the k^{th} group.

SB_{jk} = the fixed effect of the two-factor interaction between the j^{th} sex and the k^{th} group.

TSB_{ijk}= the fixed effect of the three-factor interaction between the the i^{th} selection type, j^{th} sex and the k^{th} group.

e_{ijk} = random residual error normally and independently distributed with zero mean and common variance equals unity.

RESULTS AND DISCUSSION

4.1. Growth traits:

4.1.1. Body weight (BW):

Data in **Table (1)** revealed that keel-type effect exerted significance effect on BW at all ages considered (P≤ 0.0001). The long-keel-length selected line (H) demonstrates heavier weight than the short-keel-length selected line (L) at all studied ages **(Table 2)**. These results may ascertain and reveal indirect selection response for keel-type divergent selection on BW showing that this type of selection may possibly be used effectively to boost body weight of plateaued quail populations.

These results of divergent selection herein agreed with those shown by **Nestor and Bacon (1982)**, **Darden and Marks (1988a,b)**, and **Marks (1995)** who reported similar results of the high BW selected line being heavier than those selected for low BW one at 4 wk. On the other hand, results reported by **Marks (1975 & 1993a)**, **Soltan *et al.* (1987)**, **Bahie El-Deen (1991)**, **Omran (1993)**, **Hassan (1994)**, **El-Sayed *et al.* (1995)**, **Tawefeek (1995 & 2001)** and **Badawy (2008)** in their studies of selection for the high BW, observed relative superiority of the line selected for the high BW compared to control population.

Colored populations' effect seemed generally to exert significance (P≤ 0.0001) On BW at most ages **Table (1)**. Data in **Table (2)** showed that the premier BW was for the White birds at hatch, first week and the second week (early growers), but in the 4, 6 and 8 wk it was for the Blacks (late growers).The interaction between keel-selection-type and birds-color was significant (P≤ 0.0001, **Table 1)**.

Data in **Table (2)** revealed that the heaviest BW was for the White-long-keeled birds at all studied ages. **1.2.Relative Growth Rate (RGR):**Data in **Table (3)** revealed that keel-type effect exerted significance differences (P ≤ 0.0001, P≤0.0003) on RGR during all studied periods except that from 6 to 8 wk of age.

Data in **Table (4)** revealed that the short keel-type line gave generally lower growth rate compared to their counterpart (*i.e.* long keel-type line). This in turn may declare a correlated response of RGR as indirect selection for keel-type length These results agreed to some extent with those reported by **Jones and Hughes (1978)**, **Marks (1993b)**, **Bahie El-Deen and El-Sayed (1999)** and **Badawy (2008)** as direct response to selection for body weight.

Colored populations' effect seemed generally to exert significance (P≤ 0.0001) on RGR during all studied periods except the period from 4 to 6 wk of age **Table (3).** Data in **Table (4)** showed that the highest RGR were in Black birds at period from hatch to 2 wk of age followed by 2 to 4 wk of age. However in the Browns ones the highest RGR was in the period from 4 to 6 wk of age followed by 6 to 8 wk of age.

About the interaction between keel selection type and birds color it was contributed significant differences (P≤ 0.0001, P<0.002**; Table (3)**.

Data in **Table(4)** revealed that the highest RGR for the White-long-keeled birds at RGR0-2, however in RGR2-4 the highest RGR for the Black-short-keeled birds. Also, the Black-long-keeled birds were the highest RGR at RGR4-6. On the other hand the highest RGR6-8 was The Brown-short-keeled birds.

1.3. Gain in weight (WG):

Data in Table (5) revealed that keel-type effect was generally highly significant (P≤ 0.0001) on WG during all studied periods. Data in Table (6) divulged that the long-keel-type line gave higher gain in weight compared to their counterpart (*i.e.* short keel-type line).

This in turn may declare a correlated response of WG as indirect selection for keel-type length.

Colored populations' effect in Table (7) was found to be highly significant (P≤ 0.0001, P>0.0003) on WG during all studied periods. Data in Table (8) showed that the highest WG in the period from hatch to 2 wk was in white birds. However, the highest WG in the period from 2 to 4 wk, 4wk to 6 wk of age and for the whole period from hatch to 8wk was in the Black birds. While the highest WG in the period from 6 to 8 wk of age observed in The Brown birds. So we can expect that the Black birds were the highest WG at most studied periods.

2. Keel length (KL):

There was highly significant effect of keel-type on KL traits at all studied ages (P≤0.0001) (Table 7). Data in Table (8) indicated that the long-keeled birds were the longest KL in 4, 6 and 8 wk. However, color effect in Table (7) seems to have non-significance on KL traits at 4, 6, and 8 wk of age.

About the interaction between keel selection type and birds color it was found to be significant (P≤0.0378) at 4 wk only and there was non-significant at 6 and 8 wk (Table 7). Data in Table (8) revealed that the longest KL in 4 wk were for the Black-long-keeled birds, but in 6 wk the longest KL were for the White-long-keeled birds, however in 8 wk the longest KL were for the Brown-long-keeled birds.

3. Carcass traits: (Percentage of live weight):

Data in Table (9), there was no significant effect of keel-type on carcass traits and internal organs percentage except only significance (P≤0.0001, P≤0.0002 and P≤0.0231) effect on head, gizzard and right testis percentages.

Also it observed that the highest percentage for eviscerated carcass percentage was for control line but lowest for (HL), and the heaviest percentage at most traits were for (LL) or control line (Table 10), this result may revert to method of calculating the percentage for (LL); it was divided on (LIVWT). And because this line has lowest weight, it gave high percentage. And the reversal is right for the (HL).this result revert to the same reasons explained previously.

For the effect of color on carcass trait there was significant effect in eviscerated carcass, feather, gut and right testis percentages P≤0.0268, P≤0.0086, P≤0.0138 and P≤0.043), respectively (Table 9). Data in Table (10) revealed that the heaviest eviscerated carcass percentage was for The Brown birds, but the lowest was for black birds.

For keel-type by color interaction there was no significant effect in all studied

Table (1): Least squares analysis of variance of body weight traits (g) for Japanese quail from hatch to 8 weeks of age raised at North-Sinai (El-Arish) and divergently selected for 4-wk keel length.

Source of variance	df.	BW0		df.	BW1		df.	BW2		df.	BW4		df.	BW6		df.	BW8	
		SS	Prob.		SS	Prob.		SS	Prob.		SS	Prob.		SS	Prob.		SS	Prob.
Keel type (K)	2	157.91	<.0001	2	6202.48	<.0001	2	19559.52	<.0001	2	62787.75	<.0001	2	144457.27	<.0001	2	198891.63	<.0001
Color (C)	2	33.63	<.0001	2	671.10	<.0001	2	860.83	<.0001	2	6726.02	<.0001	2	14095.81	<.0001	2	7462.04	<.0001
Sex (S)	1	0.19	0.2715	1	3.47	0.5038	1	75.38	0.1366	1	1151.29	0.0001	1	4311.85	<.0001	1	14519.59	<.0001
K x C interaction	4	5.48	<.0001	4	49.91	0.1706	4	511.23	0.0051	4	13256.49	<.0001	4	6018.06	<.0001	4	11047.11	<.0001
K x S interaction	2	0.11	0.6925	2	6.40	0.6615	2	7.59	0.894	2	45.84	0.746	2	251.07	0.5682	2	3104.18	0.01
S x C interaction	2	0.07	0.7944	2	12.31	0.452	2	93.85	0.2514	2	59.54	0.6835	2	454.24	0.3601	2	416.98	0.5342
K x C x S interaction	4	0.14	0.9182	4	1.86	0.9933	4	75.85	0.6916	4	183.89	0.6714	4	944.94	0.3735	4	635.99	0.7511
Error	324	49.69		324	2506.13		324	10964.48		324	25321.73		322	71375.22		321	106531.45	

BW0 =Body weight at hatch, **BW1**=Body weight at 1 wk of age, **BW2** = Body weight at 2 wk of age, **BW4** = Body weight at 4 wk of age, **BW6**= Body weight at 6 wk of age, **BW8**= Body weight at 8 wk of age

Table (2): Least squares means ±SE of factors affecting body weight traits (g) for Japanese quail at different ages raised at North-Sinai (El-Arish) and divergently selected for 4-wk keel length.

Traits				BW0			BW1			BW2			BW4			BW6			BW8		
				Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
Overall means	Keel type	Long		10.83	±	0.04^{a}	42.66	±	0.28^{a}	97.74	±	0.59^{a}	177.82	±	1.07^{a}	242.12	±	1.53^{a}	277.76	±	1.91^{a}
		Control		9.89	±	0.04^{b}	36.62	±	0.26^{b}	86.29	±	0.56^{b}	161.72	±	1.02^{b}	217.01	±	1.47^{b}	246.32	±	1.84^{b}
		Short		8.68	±	0.04^{c}	30.70	±	0.28^{c}	75.42	±	0.60^{c}	142.80	±	1.09^{c}	184.59	±	1.56^{c}	212.38	±	1.94^{c}
	Color	White		10.08	±	0.06^{a}	38.15	±	0.39^{a}	89.17	±	0.82^{a}	160.79	±	1.50^{b}	214.89	±	2.14^{b}	244.60	±	2.66^{ab}
		Brown		9.95	±	0.04^{b}	37.13	±	0.28^{b}	84.56	±	0.60^{b}	155.69	±	1.10^{c}	206.99	±	1.58^{c}	240.63	±	1.96^{b}
		Black		9.36	±	0.03^{c}	34.71	±	0.20^{c}	85.73	±	0.42^{b}	165.85	±	0.77^{a}	221.85	±	1.11^{a}	251.23	±	1.38^{a}
Interaction Means	Keel type x Color interaction	Long	White	10.88	±	0.10	45.12	±	3.23	101.01	±	4.73	182.78	±	8.35	247.04	±	12.77	285.39	±	20.24
			Brown	10.79	±	0.13	43.36	±	2.57	96.69	±	3.92	180.42	±	8.72	238.25	±	10.81	277.09	±	22.73
			Black	10.55	±	0.26	40.35	±	2.46	96.40	±	5.02	177.81	±	7.69	246.39	±	13.28	279.29	±	22.31
		Control	White	10.22	±	0.32	37.93	±	1.47	86.62	±	6.16	158.51	±	10.10	213.14	±	19.33	241.74	±	21.50
			Brown	10.08	±	0.44	37.25	±	2.15	85.62	±	4.41	161.84	±	11.20	214.62	±	12.97	248.33	±	16.20
			Black	9.42	±	0.28	34.64	±	2.01	85.72	±	4.74	165.34	±	5.91	223.36	±	13.06	250.28	±	14.66
		Short	White	9.14	±	0.34	31.36	±	1.90	81.14	±	6.66	142.21	±	8.82	186.20	±	11.88	207.54	±	15.50
			Brown	8.97	±	0.57	30.78	±	2.91	71.36	±	5.95	124.82	±	11.35	168.39	±	12.06	196.92	±	17.95
			Black	8.13	±	0.57	29.13	±	4.03	75.06	±	8.19	154.45	±	10.17	195.89	±	22.53	224.26	±	23.63

BW0=Body weight at hatch, **BW1=** Body weight at 1 wk of age, **BW2=** Body weight at 2 wk of age, **BW4=** Body weight at 4 wk of age, **BW6=** Body weight at 6 wk of age, **BW8=** Body weight at 8 wk of age.

a,b,c means the different superscripts between treatments differ significant (P<0.05.

Table (3): Least squares analysis of variance of factors affecting relative growth rates for Japanese quail from hatch to 8 wk of age raised in North-Sinai (El-Arish) and divergently selected for 4wk keel length.

Source of variance	df.	RGR0-2		RGR2-4		df.	RGR4-6		df.	RGR6-8	
		SS	Prob.	SS	Prob.		SS	Prob.		SS	Prob.
Keel type (K)	2	207.60	<.0001	221.78	0.0003	2	469.85	<.0001	2	44.41	0.1209
Color (C)	2	546.92	<.0001	3053.77	<.0001	2	7.04	0.7803	2	408.14	<.0001
Sex (S)	1	4.79	0.2896	99.49	0.0069	1	66.35	0.0313	1	320.39	<.0001
K x C interaction	4	315.23	<.0001	3503.12	<.0001	4	1472.50	<.0001	4	178.91	0.0022
K x S interaction	2	2.08	0.7835	0.06	0.9979	2	5.47	0.8248	2	169.84	0.0004
S x C interaction	2	11.79	0.2514	70.13	0.0754	2	292.51	<.0001	2	20.53	0.3752
K x C x S interaction	4	15.80	0.4473	9.46	0.9508	4	83.14	0.2125	4	26.40	0.6399
Error	324	1377.82		4359.15		322	4568.08		321	3351.37	

RGR_{0-2}=RGR during the period from hatch to 2 wk of age, **RGR_{2-4}**= RGR during the period from 2 to 4 wk of age, **RGR_{4-6}**= RGR during the period from 4 to 6 wk of age, **RGR_{6-8}**= RGR during the period from 6 to 8 wk of age.

Table (4): Least squares means ±SE of factors affecting relative growth rate traits for Japanese quail from hatch to 8 weeks of age raised in North-Sinai (El-Arish) and divergently selected for 4wk keel length.

Traits				RGR_{0-2}			RGR_{2-4}			RGR_{4-6}			RGR_{6-8}		
				Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
Overall means	**Keel type**	**Long**		160.44	±	0.23	59.14	±	0.40	29.93	±	0.42	13.83	±	0.36
		Control		158.61	±	0.21	61.22	±	0.37	29.07	±	0.38	12.83	±	0.33
		Short		158.41	±	0.24	59.55	±	0.42	26.60	±	0.43	13.31	±	0.37
	Color	**White**		159.37	±	0.29	57.04	±	0.52	28.61	±	0.53	12.55	±	0.46
		Brown		157.59	±	0.21	58.76	±	0.37	28.65	±	0.39	14.94	±	0.33
		Black		160.51	±	0.15	64.12	±	0.26	28.34	±	0.27	12.48	±	0.23
Interaction Means	**Keel type x Color interaction**	**Long**	**White**	161.03	±	0.52	57.63	±	0.92	29.87	±	0.94	14.29	±	0.81
			Brown	159.79	±	0.37	60.38	±	0.65	27.63	±	0.67	14.84	±	0.57
			Black	160.50	±	0.258	59.41	±	0.46	32.27	±	0.47	12.35	±	0.40
		Control	**White**	157.68	±	0.44	58.69	±	0.782	29.19	±	0.80	12.59	±	0.69
			Brown	157.81	±	0.37	61.49	±	0.648	28.44	±	0.68	14.53	±	0.58
			Black	160.34	±	0.25	63.49	±	0.45	29.59	±	0.47	11.36	±	0.40
		Short	**White**	159.38	±	0.55	54.79	±	0.98	26.77	±	1.01	10.76	±	0.86
			Brown	155.17	±	0.37	54.40	±	0.65	29.87	±	0.67	15.44	±	0.57
			Black	160.68	±	0.26	69.47	±	0.46	23.17	±	0.47	13.73	±	0.41

RGR_{0-2}=RGR during the period from hatch to 2 wk of age, **RGR_{2-4}**= RGR during the period from 2 to 4 wk of age, **RGR_{4-6}**= RGR during the period from 4 to 6 wk of age, **RGR_{6-8}**= RGR during the period from 6 to 8 wk of age.

factors except right testis weight ($P \leq 0.0004$) (Table 9).

CONCLUSION

The superiority attained by colored strains was exchangeable between different plumages where some were early growers and others were late growers. However, growth and carcass performance was higher in the long keel-length selected line quails. The keel-selection-type by birds' color interaction was found to be significant to highly significant on most cases, revealing that birds' color may performed different genetic make-up in quails.

Moreover selection for keel length proved to show correlated response of most growth traits. It is therefore, this high-density multi-trait data analysis was successful to expose the possibility of using divergent selection for keel-length at 4 wk as indirect selection tool to improve growth performance of Japanese quails.

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Table (5): Least squares analysis of variance of factors affecting weight gain traits for Japanese quail from hatch to 8wk of age raised at North-Sinai (El-Arish) and divergently selected for 4wk keel length.

Source of variance	df.	WG0-2		df.	WG2-4		df.	WG4-6		df.	WG6-8		df.	WG0-8	
		SS	Prob.		SS	Prob.		SS	Prob.		SS	Prob.		SS	Prob.
Keel type (K)	2	16243.42	<.0001	2	12603.35	<.0001	2	16843.06	<.0001	2	4608.31	<.0001	2	187881.05	<.0001
Color (C)	2	793.25	<.0001	2	6544.34	<.0001	2	1205.54	0.0003	2	1219.57	<.0001	2	8404.37	<.0001
Sex (S)	1	68.07	0.1399	1	637.50	<.0001	1	953.34	0.0003	1	3029.63	<.0001	1	14409.60	<.0001
K x C interaction	4	555.43	0.0016	4	10102.74	<.0001	4	1860.21	<.0001	4	1344.03	0.0004	4	11435.20	<.0001
K x S interaction	2	8.46	0.8729	2	16.35	0.7292	2	92.09	0.5261	2	1651.93	<.0001	2	3117.45	0.0086
S x C interaction	2	90.54	0.2346	2	68.88	0.2654	2	983.98	0.0012	2	95.49	0.4711	2	428.59	0.5155
K x C x S interaction	4	77.92	0.6438	4	37.11	0.8378	4	287.36	0.4055	4	72.93	0.8856	4	648.59	0.734
Error	324	10071.17		324	8377.35		322	23040.97		321	20317.54		321	103606.90	

WG_{0-2}=Body weight gain from hatch to 2 wk of age , **WG_{2-4}**=Body weight gain from 2 wk of age to 4 wk of age, **WG_{4-6}**=Body weight gain from 4 wk of age to 6 wk of age, **WG_{6-8}**=Body weight gain from 6 wk of age to 8 wk of age, **WG_{0-8}**=Body weight gain from hatch to 8 wk of age.

Table (6): Least square means ±SE of factors affecting weight gain traits (g) for Japanese quail from hatch to 8 wk of age raised at North-Sinai (El-Arish) and divergently selected for 4-wk keel length.

Traits				WG0-2			WG2-4			WG4-6			WG6-8			WG0-8		
				Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
Overall means	**Keel type**	**Long**		87.29	±	0.62	82.31	±	0.56	63.55	±	0.93	36.70	±	0.88	269.85	±	1.98
		Control		76.08	±	0.56	75.91	±	0.51	55.24	±	0.86	29.72	±	0.81	236.78	±	1.83
		Short		67.11	±	0.64	64.64	±	0.58	43.00	±	0.97	26.16	±	0.91	200.87	±	2.06
	Color	**White**		79.51	±	0.79	71.58	±	0.72	54.30	±	1.19	29.43	±	1.12	234.81	±	2.54
		Brown		74.61	±	0.57	71.14	±	0.52	51.58	±	0.87	33.69	±	0.82	230.77	±	1.84
		Black		76.36	±	0.40	80.14	±	0.37	55.93	±	0.61	29.46	±	0.57	241.92	±	1.30
Interaction Means	**Keel type x Color interaction**	**Long**	**White**	90.12	±	1.39	81.78	±	1.27	64.26	±	2.11	38.35	±	1.99	274.51	±	4.49
			Brown	85.90	±	0.99	83.73	±	0.90	57.83	±	1.50	38.85	±	1.41	266.30	±	3.18
			Black	85.85	±	0.697	81.42	±	0.636	68.57	±	1.06	32.90	±	0.99	268.74	±	2.25
		Control	**White**	76.41	±	1.19	71.89	±	1.084	54.63	±	1.80	28.60	±	1.70	231.52	±	3.83
			Brown	75.54	±	0.99	76.22	±	0.90	53.33	±	1.52	33.68	±	1.43	238.05	±	3.23
			Black	76.30	±	0.69	79.63	±	0.63	57.76	±	1.05	26.89	±	0.99	240.77	±	2.23
		Short	**White**	72.01	±	1.49	61.07	±	1.36	43.99	±	2.26	21.34	±	2.13	198.41	±	4.80
			Brown	62.38	±	0.99	53.46	±	0.899	43.57	±	1.50	28.53	±	1.41	187.95	±	3.18
			Black	66.93	±	0.70	79.39	±	0.64	41.44	±	1.06	28.61	±	1.00	216.25	±	2.26

WG_{0-2}=Body weight gain from hatch to 2 wk of age , **WG_{2-4}**=Body weight gain from 2 wk of age to 4 wk of age, **WG_{4-6}**=Body weight gain from 4 wk of age to 6 wk of age, **WG_{6-8}**=Body weight gain from 6 wk of age to 8 wk of age, **WG_{0-8}**=Body weight gain from hatch to 8 wk of age.

Table (7): Least squares analysis of variance of keel length traits (mm) for Japanese quail at 4, 6, and 8 wk of age raised at North-Sinai (EL-Arish) and divergently selected for 4-wk keel length.

Source of variance	4Wk.			6Wk.			8Wk.		
	df.	SS	Prob.	df.	SS	Prob.	df.	SS	Prob.
Keel type (K)	2	2287.17	<.0001	2	2173.94	<.0001	2	2254.16	<.0001
Color (C)	2	13.36	0.0549	2	10.65	0.0962	2	21.62	0.0645
Sex (S)	1	11.52	0.0252	1	6.08	0.1017	1	62.74	<.0001
K x C interaction	4	23.46	0.0378	4	5.93	0.6227	4	33.13	0.0783
K x S interaction	2	6.10	0.2637	2	2.78	0.541	2	1.88	0.7866
S x C interaction	2	37.42	0.0003	2	27.83	0.0024	2	38.45	0.0079
K x C x S interaction	4	17.37	0.1094	4	10.71	0.3167	4	24.07	0.1905
Error	324	738.71		322	726.72		321	1254.97	

Table (8): Least squares means ±SE of factors affecting keel length trait of Japanese quail at 4, 6 and 8 week of age raised in Sinai (El-Arish) and divergently selected for 4wk keel length.

Traits				4Wk.			6Wk.			8Wk.		
				Mean	±	SE	Mean	±	SE	Mean	±	SE
Overall means	**Keel type**	**Long**		65.28	±	0.16	69.12	±	0.15	74.39	±	0.20
		Control		61.02	±	0.15	65.26	±	0.15	70.67	±	0.19
		Short		57.30	±	0.16	61.52	±	0.15	66.93	±	0.21
	Color	**White**		61.54	±	0.22	65.60	±	0.21	70.82	±	0.28
		Brown		60.98	±	0.16	65.19	±	0.16	70.84	±	0.21
		Black		61.08	±	0.11	65.12	±	0.11	70.32	±	0.15
Interaction Means	**Keel type x Color interaction**	**Long**	**White**	65.13	±	1.71	69.19	±	1.67	74.39	±	1.74
			Brown	64.86	±	1.64	68.93	±	1.73	75.21	±	4.45
			Black	65.38	±	1.83	69.03	±	1.84	73.77	±	1.88
		Control	**White**	61.21	±	1.09	65.41	±	1.16	70.79	±	1.68
			Brown	60.83	±	0.62	65.23	±	0.67	70.73	±	0.82
			Black	60.94	±	0.60	65.08	±	0.83	70.39	±	0.93
		Short	**White**	58.44	±	1.35	62.30	±	1.25	67.35	±	2.11
			Brown	57.26	±	1.45	61.39	±	1.65	66.56	±	2.10
			Black	56.91	±	2.21	61.25	±	1.95	66.82	±	1.65

Table (9): Least squares analysis of variance of carcass traits (Percentage of live weight) (%) for Japanese quail raised in North-Sinai (El-Arish) and divergently selected for 4-wk keel length.

Carcass traits

Source of variance	df.	CRCS_P		BLD_P		FTR_P		HD_P	
		SS	Prob.	SS	Prob.	SS	Prob.	SS	Prob.
Keel type (K)	2	41.48	0.43	6.65	0.12	0.22	0.94	9.50	<.0001
Color (C)	2	183.73	0.03	1.84	0.54	18.86	0.01	0.07	0.89
Sex (S)	1	1201.48	<.0001	7.95	0.02	5.26	0.10	2.07	0.01
K x C interaction	4	96.94	0.41	10.22	0.16	5.08	0.61	1.66	0.23
K x S interaction	2	84.99	0.18	5.35	0.17	4.62	0.30	1.37	0.10
S x C interaction	2	141.94	0.06	0.44	0.86	0.37	0.91	1.71	0.06
K x C x S interaction	4	136.24	0.24	12.12	0.10	6.11	0.52	0.17	0.96
Error	78	1890.18		116.83		145.59		22.48	

Internal organs

Source of variance	df.	HRT_P		df.	GLN_P		df.	GZR_P		df.	GUT_P		df.	LVR_P		df.	SPL_P	
		SS	Prob.		SS	Prob.		SS	Prob.		SS	Prob.		SS	Prob.		SS	Prob.
Keel type (K)	2	0.03	0.37	2	0.58	0.11	2	0.97	0.00	2	2.06	0.20	2	0.42	0.33	2	0.02	0.26
Color (C)	2	0.04	0.29	2	0.71	0.07	2	0.14	0.27	2	5.65	0.01	2	0.25	0.52	2	0.00	0.85
Sex (S)	1	0.22	0.00	1	0.09	0.40	1	0.86	0.00	1	11.37	<.0001	1	26.72	<.0001	1	0.02	0.11
K x C interaction	4	0.13	0.11	4	1.02	0.10	4	0.11	0.73	4	1.49	0.67	4	1.74	0.06	4	0.05	0.15
K x S interaction	2	0.03	0.39	2	0.38	0.23	2	0.01	0.90	2	0.51	0.67	2	1.86	0.01	2	0.01	0.44
S x C interaction	2	0.03	0.42	2	0.72	0.06	2	0.02	0.86	2	0.28	0.80	2	0.30	0.46	2	0.00	0.73
K x C x S interaction	4	0.04	0.65	4	0.86	0.16	4	0.30	0.23	4	0.24	0.98	4	0.19	0.90	4	0.08	0.04
Error	78	1.26		75	9.47		78	4.10		77	48.03		78	14.66		75	0.55	

Sex organs

Source of variance	Female			Male					
	df.	OVR_P		df.	LT_P		df.	RT_P	
		SS	Prob.		SS	Prob.		SS	Prob.
Keel type (K)	2	9.18	0.30	2	0.27	0.54	2	1.14	0.02
Color (C)	2	12.90	0.19	2	0.28	0.53	2	0.94	0.04
K x C interaction	4	16.67	0.36	4	0.14	0.96	4	3.62	0.00
Error	38	141.83		37	7.93		38	5.22	

CRCS_P= Precentage of Eviscrated Carcass **, BLD_P**= Precentage of Blood **, FTR**_P= Precentage of Feather **, HD_P**= Precentage of Head **, HRT_P**= Precentage of Heart **, GLN_P**= Precentage of Glandular stomach **, GZR_P**= Precentage of Gizzard **,**
GUT_P= Precentage of Gut **, LVR_P**= Precentage of Liver **, SPL_P**= Precentage of Spleen **, OVR_P**= Precentage of Ovary and Oviduct **, LT_P**= Precentage of Left testis **, RT_P**= Precentage of Right testis.

Table (10): Least square means ±SE of factors affecting carcass (Precentage of live weight) (%) traits for Japanese quail that raised at North-Sinai (El-Arish) and divergently selected for 4-wk keel length.

Traits				CRCS_P			BLD _P			FTR _P			HD _P		
				Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
Overall means	Keel type	Long		68.17	±	0.89	3.31	±	0.22	4.14	±	0.25	4.06	±	0.10
		Control		69.77	±	0.89	3.32	±	0.22	4.12	±	0.25	4.28	±	0.10
		Short		68.62	±	0.89	3.89	±	0.22	4.02	±	0.25	4.83	±	0.10
	Color	White		69.08	±	1.00	3.68	±	0.25	4.32	±	0.28	4.35	±	0.11
		Brown		70.33	±	0.90	3.31	±	0.22	3.48	±	0.25	4.42	±	0.10
		Black		67.15	±	0.76	3.53	±	0.19	4.48	±	0.21	4.40	±	0.08
Interaction Means	Keel type x Color interaction	Long	White	69.25	±	1.74	3.62	±	0.43	4.23	±	0.48	4.19	±	0.19
			Brown	68.23	±	1.56	3.04	±	0.39	3.34	±	0.43	3.86	±	0.17
			Black	67.02	±	1.32	3.27	±	0.33	4.83	±	0.37	4.14	±	0.14
		Con.	White	69.71	±	1.74	2.82	±	0.43	4.34	±	0.48	4.27	±	0.19
			Brown	72.92	±	1.56	3.50	±	0.39	3.41	±	0.43	4.38	±	0.17
			Black	66.68	±	1.32	3.64	±	0.33	4.61	±	0.37	4.18	±	0.14
		Short	White	68.28	±	1.74	4.60	±	0.43	4.39	±	0.48	4.58	±	0.19
			Brown	69.83	±	1.56	3.40	±	0.39	3.68	±	0.43	5.01	±	0.17
			Black	67.74	±	1.32	3.67	±	0.33	4.00	±	0.37	4.89	±	0.14

Internal organs

Traits				HRT _P			GLN _P			GZR _P			GUT _P			LVR _P			SPL _P		
				Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE	Mean	±	SE
Overall means	Keel type	Long		0.81	±	0.02	0.34	±	0.06	1.64	±	0.04	2.52	±	0.15	2.03	±	0.08	0.22	±	0.02
		Control		0.85	±	0.02	0.54	±	0.07	1.76	±	0.04	2.46	±	0.14	2.20	±	0.08	0.25	±	0.02
		Short		0.85	±	0.02	0.42	±	0.06	1.89	±	0.04	2.81	±	0.14	2.12	±	0.08	0.26	±	0.02
	Color	White		0.80	±	0.03	0.34	±	0.08	1.71	±	0.05	2.46	±	0.16	2.19	±	0.09	0.25	±	0.02
		Brown		0.86	±	0.02	0.56	±	0.06	1.81	±	0.04	2.40	±	0.15	2.10	±	0.08	0.25	±	0.02
		Black		0.85	±	0.02	0.40	±	0.05	1.77	±	0.04	2.92	±	0.12	2.06	±	0.07	0.24	±	0.01
Interaction Means	Keel type x Color interaction	Long	White	0.72	±	0.04	0.31	±	0.13	1.56	±	0.08	2.12	±	0.28	1.91	±	0.15	0.21	±	0.03
			Brown	0.87	±	0.04	0.32	±	0.11	1.65	±	0.07	2.45	±	0.26	2.01	±	0.14	0.20	±	0.03
			Black	0.84	±	0.03	0.38	±	0.09	1.70	±	0.06	2.99	±	0.21	2.17	±	0.12	0.26	±	0.02
		Con.	White	0.83	±	0.04	0.34	±	0.16	1.72	±	0.08	2.48	±	0.28	2.24	±	0.15	0.27	±	0.03
			Brown	0.89	±	0.04	0.88	±	0.11	1.79	±	0.07	2.23	±	0.25	2.19	±	0.14	0.26	±	0.03
			Black	0.83	±	0.03	0.41	±	0.09	1.75	±	0.06	2.67	±	0.21	2.16	±	0.12	0.22	±	0.02
		Short	White	0.87	±	0.04	0.38	±	0.13	1.83	±	0.08	2.79	±	0.28	2.41	±	0.15	0.26	±	0.03
			Brown	0.81	±	0.04	0.48	±	0.11	1.98	±	0.07	2.53	±	0.25	2.10	±	0.14	0.28	±	0.03
			Black	0.876	±	0.034	0.396	±	0.095	1.853	±	0.061	3.099	±	0.211	1.851	±	0.116	0.235	±	0.02

Table (10). Con: Least square means ±SE of factors affecting carcass (Precentage of live weight) (%) traits for Japanese quail that raised at North-Sinai (El-Arish) and divergently selected for 4-wk keel length.

Traits				Sex organs: Female Sex Organs			LT_P			RT_P		
				Mean	±	SE	Mean	±	SE	Mean	±	SE
Overall means	Keel type	Long		6.16	±	0.50	1.57	±	0.12	1.46	±	0.10
		Control		6.50	±	0.52	1.49	±	0.12	1.45	±	0.10
		Short		5.41	±	0.50	1.68	±	0.13	1.79	±	0.10
	Color	White		5.22	±	0.56	1.66	±	0.14	1.78	±	0.11
		Brown		6.41	±	0.52	1.47	±	0.12	1.47	±	0.10
		Black		6.44	±	0.42	1.61	±	0.10	1.44	±	0.08
Interaction Means	Keel type x Color interaction	Long	White	5.52	±	0.97	1.60	±	0.23	1.34	±	0.19
			Brown	5.79	±	0.86	1.48	±	0.21	1.62	±	0.17
			Black	7.17	±	0.73	1.63	±	0.19	1.42	±	0.15
		Con.	White	4.84	±	0.97	1.59	±	0.23	1.41	±	0.19
			Brown	7.53	±	0.97	1.43	±	0.21	1.44	±	0.17
			Black	7.14	±	0.73	1.44	±	0.17	1.51	±	0.14
		Short	White	5.31	±	0.97	1.80	±	0.27	2.60	±	0.19
			Brown	5.91	±	0.86	1.48	±	0.21	1.37	±	0.17
			Black	5.01	±	0.73	1.76	±	0.17	1.41	±	0.14

CRAFTRFTR_P= Carcass after feathering precentage, **CRCSWT_P=** Eviscerated carcass precentage, **BLDWT_P=** Blood precentage, **FTRWT_P=** Feather precentage, **HDWT_P=** Head precentage, **HRTWT_P=** Heart precentage, **GLNWT_P=** Glandular stomach precentage, **GZRWT_P=** Gizzard precentage, **GUTWT_P=** Gut precentage, **LVRWT_P=** Liver precentage, **SPLWT_P=** Spleen precentage, **OVRWT_P=** Ovary and Oviduct precentage, **LTWT_P=** Left testis precentage, **RTWT_P=** Right testis precentage.

a,b,c Means having different litters in the same column are significantly different at (P≤ 0.05) using Duncan's Multiple Range test.

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الملخص العربى

تأثير نوع طول عظمة القص وتفاعل الريش على أداء النمو الحدث ومكوّنات الذبيحة في السمان الياباني

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أجريت هذه الدراسة بمزرعة الدواجن ، قسم الإنتاج الحيواني والداجنى، كلية العلوم الزراعية البيئية بالعريش، شمال سيناء، جامعة قناة السويس خلال الفترة من اكتوبر ٢٠١١م إلى نوفمبر ٢٠١٢. هدفت التجربة إلى دراسة تأثير طول عظمة القص على صفات النمو ومكونات الذبيحة. تم تأسيس القطيع من ثلاث سلالات مختلفة الألوان تم شراءها من كلية الزراعة - جامعة القاهرة. فقست قطعان التجربة من ١٥٠٠ بيضة (٥٠٠ بيضة لكل مجموعة ريش). وكانت مجاميع الألوان للسمان هي الأسود (النوع البرى) والبنى والأبيض (في بعض الأحيان بها بعض الريشات السوداء أو البنية على قمة ظهرها او على رؤوسها). تم الإنتخاب فرديا على عمر ٤ أسابيع لطول عظمة القص ومن ثم تم تقسيمهم على حسب اللون، حيث كان ١/٣ الأعلى لكل لون ريش كان يتبع الخط العالي لطول عظمة القص (H) أما ال ١/٣ الأدنى صنف على أنه الخط المنخفض لطول عظمة القص (L)، وباقي كل مجموعة إعتبر أنه مجموعة الكنترول (C). وكان التداخل بين لون الريش ونوع طول عظمة القص فإنه أعطى ٩ مجموعات وهي كالتالي:

G1 = (Bl_H); G2 = (Bl_C); G3 = (Bl_L); G4 = (Br_H); G5 = (Br_C); G6 = (Br_L); G7 = (Wt_H); G8 = (Wt_C); G9 = (Wt_L).

العليقة التجربيية المستخدمة كانت في شكل ناعم من فول الصويا والذرة الصفراء وكانت تقريبا ٢٣% بروتين خام و ٢٨٥٠ ك.ك طاقة / كجم. وكانت التغذية وشرب الماء كانت لحد الشبع.أشارت النتائج بأن التفاعل بين طول عظمةالقص ونوع لون الريش من معنوي إلى عالي المعنوية على كل صفات النمو. فبالنسبة لوزن الجسم (BW) فكانت المجموعة الأثقل وزنا في كل الاعمار المدروسة كانت لمجموعة الريش الأبيض ذو عظمة القص العالية (Wt-H) أما بالنسبة لمعدل الزيادة في وزن الجسم (RGR) فكانت المجموعة الأعلى هي الطيور بيضاء الريش طوية عظمة القص في الأسبوع الثاني وللطيور السوداء في الأسبوع ٤-٦ أما في ٢-٤ كانت للطيور السوداء قصيرة عظمة القص أما في ٦-٨ كانت للطيور البنية قصيرة عظمة القص .وفيما يتعلق بزيادة الوزن (WG) فكان أعلى مجموعة للطيور طويلة عظمة القص ففي الأسابيع ٠-٢، ٠-٨ كانت للطيور البيضاء أما في الأسابيع ٢-٧ ، ٦-٨ كانت للبنية والطيور السوداء كانت الأعلى في الأسابيع ٤-٦. أما بالنسبة للتداخل بين عظمة القص واللون فلم يعطي أي معنوية على النسب المئوية المختلفة من مكونات الذبيحة إلا على وزن الخصية اليمني حيث كانت (P< 0.0004).

الكلمات الاسترشادية: عظمة القص، الريش، النمو، مكوّنات الذبيحة، السمان الياباني.

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